REMARKS

Claims 1, 5, 9 and 12 have been amended. New claims 16-18 have been added. It should be appreciated that the new claims merely clarify the invention as disclosed in the specification and do not add new matter.

Claims 5 and 12 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Number 5,923,329 to Beale. The Applicant respectfully traverses this rejection.

U.S. Patent Number 5,923,329 to Beale discloses a method of generating a body fitted grid using three scalar functions to improve the likelihood of convergence. The method includes the steps of preparing a CAD model using a computer. The method also includes the steps of generating a reference grid having grid coordinates and nodes disposed at locations relative to the grid coordinates. The reference grid is representative of space associated with the object model. The reference grid is generated by providing a set of reference scalars associated with the nodes of the reference grid, and providing a current grid having nodes associated the reference grid. The method iteratively obtains calculated values associated with nodes on the reference grid, but calculated based on associated nodes on the current grid. The method compares the calculated values associated with nodes in the reference grid with at least a reference scalar associated with a corresponding node of the reference grid to determine residuals associated with some nodes, and determines if a residual associated with a node is within a predetermined tolerance. It the residual is not within a predetermined tolerance, the methodology alters a location of the associated node to reduce the residual by modifying coordinates of the current grid. If the residual associated with each node having an associated scalar is within a predetermined tolerance, the methodology provides the reference grid in dependence upon coordinate locations of the current grid. The methodology adaptively modifies

the grid, based on a comparison of nodal values with scalar values. When convergence is attained, the current grid forms the reference grid. Alternatively, the reference grid is determined based on the current grid. A fluid dynamic analysis is then carried out and the computer-aided design model is complete. If the model is unacceptable, the model is altered and the grid generation and evaluation process takes place. Alternatively, the fluid dynamics analysis is carried out iteratively along with the grid generation. This is to provide for grid adaptation and enhanced grid control. The results allow boundary points to be manually or automatically altered to improve the results of the analysis. Beale '329 does not disclose a system and method that eliminates the need to update the CAD model to evaluate the effect of a change to a design parameter.

In contradistinction, the present invention discloses a system and method for computer-aided engineering analysis using direct mesh manipulation of a mesh model. The system includes a computer system having a memory, a processor, a user input device and a display device. A computer-generated geometric model in a computer-aided design (CAD) format is stored in the memory of the computer system. A user utilized the computer system to convert the CAD model into a mesh model. The user iteratively evaluates the mesh model using a computer-aided engineering (CAE) analysis. The user can modify a predetermined design criteria based on the CAE analysis, and update the mesh model by direct mesh manipulation using a Dirichlet parameter distribution to determine deformation of a surface of the mesh model. The iterative process continues until a predetermined response is generated. The updated mesh model is available for further study.

The method includes the steps of selecting a geometric model in a computer-aided design (CAD) format. The methodology converts the CAD model into a mesh model. The

methodology iteratively evaluates the mesh model using a computer-aided engineering (CAE) analysis to generate a response. Based on the response, the methodology determines whether to vary a design parameter. It determined to continue, the methodology modifies a surface of the mesh model by varying a predetermined parameter using direct surface manipulation (DSM). The methodology updates the mesh model and returns back to the step of running the CAE simulation on the mesh model to generate a response. If the response is determined to be acceptable, the results of the CAE simulation are available for further CAE analysis. Three techniques are provided for modifying a surface feature, including using a Dirichlet parameter distribution to determine the displacement of the surface feature; modeling the surface feature as an elastic sheet to determine deformation; and enclosing the feature within a lattice structure and using lattice deformation to determine surface deformation.

Beale '329 does not disclose, anticipate or otherwise suggest the claimed invention of claims 5 and 12. Beale '329 merely discloses a method of generating a grid or mesh around a surface, for use in evaluating the grid, such as in a grid boundary evaluation and modification of grid adaptation. In Beale, a CAD model is utilized to generate a reference grid. After a satisfactory reference grid is obtained, a CAE analysis, such as a CFD analysis, is performed. If the results of the CFD analysis are not acceptable, the methodology returns to the CAD model and updates the CAD model and continues the iterative steps of regenerating the reference grid and performing the CAD analysis.

Beale '329 clearly does not disclose a novel method of direct surface manipulation of a mesh model in order to make changes to a design parameter associated with the model. In fact, the present invention solves an entirely different problem than that solved by Beale '329. In Beale '329 a method of generating a mesh model from a CAD model by comparing a current

grid to a reference grid is provided. This is essentially the same step as disclosed by the Applicant in the prior art discussion, FIG. 2, block 105, in comparison to the present invention in FIG. 3, block 210. After obtaining an acceptable grid, Beale '329 discloses performing a CFD analysis, and if the CFD analysis results are not acceptable, returning to the CAD model. These are essentially the same step disclosed by the Applicant in the prior art FIG. 2, blocks 110, 120 and 125. The problem with both the prior art methodology discussed with respect to FIG. 2 in Applicant's invention and in Beale '329, is that it is extremely expensive and time consuming to update a CAD model. The Applicant's invention overcomes the problem of iteratively updating the CAD model in order to evaluate the effect of a change to a design parameter.

The novel feature of the present invention is that it takes a mesh model, performs a computer-aided engineering analysis, such as CFD, varies a design parameter and updates the mesh model using direct surface manipulation of the mesh model until the desired response is obtained. The present invention eliminates the iterative step of updating of the CAD model each time a design parameter is modified. Therefore, it is respectfully submitted that claims 5 and 12 as amended, and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. §102(b).

Claims 1-2, and 4 were rejected under 35 U.S.C. §103(a) as being unpatentable over Beale in view of Hariya et al. (U.S. Patent Number 6,578,189). The Applicant respectfully traverses this rejection for the reasons set forth above.

In addition, U.S. Patent Number 6,578,189 to Hariya et al. discloses a system and method of automatically generating a hexahedral mesh model for use in a numerical analysis simulation. The system includes a command analyzer 7 that analyzes commands entered by the system from an input/output device 1 and instructs the components of the mesh generation device to perform

processing. The system also includes a shape model reader 2, a polygonal patch generator 3, a mapping model generator, and an analysis mesh generator 5. The system further includes a model database 6 in which shape models, polygonal patches, mapping models and hexahedral meshes are related and stored. The method of generating a hexahedral mesh includes the steps of reading an analysis object shape model and generating polygonal patches on a surface of the shape model. The method also includes the steps of generating a mapping model from the polygonal patches that is modeled after the shape model using a grid and generating an analysis mesh from the mapping model.

None of the references, alone or in combination with each other, teach or otherwise suggest the claimed invention of claim 1 as amended, or the claims dependent therefrom. Specifically, the Beale '329 reference merely discloses a method of generating a mesh model from a CAD model, utilizing a grid correction procedure that compares the current grid to a reference grid. The Hariya et al. '189 reference merely discloses a hexahedral mesh generation device that generates a hexahedral mesh that is available for use in other analysis such as CAE, and the mesh is stored in a model database. Both the reference to Beale '329 and to Hariya et al. '189 provide a system for generating a mesh model that is available for other types of analysis, such as a CAE analysis. Neither Beale '329 nor Hariya et al. '189 disclose a system for taking a CAD model, generating a mesh model from the CAD model, and iteratively performing a CAE analysis using the mesh model, varying a design parameter, and remeshing the model using direct surface manipulation, until the desired CAE results are obtained, as disclosed by the Applicant. Again, the mesh model obtained using the system of Beale or Hariya et al. is merely an input to the novel, iterative system of the Applicant's invention whereby the mesh model is

analyzed using a CAE program, a design parameter is modified, the model is remeshed, and the CAE program is rerun. This iterative process continues until the desired results are obtained.

The combination of references, if even combinable, would not render obvious Applicant's invention as claimed in claim 1 as amended, or the claims dependent therefrom. The combination of Beale and Hariya et al. would yield a method of generating a mesh model utilizing a grid correction procedure that compares the current grid to a reference grid, and the reference grid and the current grid would be stored in a model database.

Such a combination is clearly distinguishable from the Applicant's invention, in that the present invention is a system and method that generates only generates one CAD model, generates a mesh model, and iteratively performs a CAE analysis and updates a design parameter and remeshes the model. The advantage of the present invention is that the CAD model is not updated as part of the iterative design process.

According to the MPEP 2141, the standard to follow in determining obviousness is that factual inquiries set forth in *Graham v. John Deere*, 383 U.S. 1, 148 USPQ 459 (1966). These include determining the scope and contents of the prior art, ascertaining the difference between the prior art and the claims in issue, resolving the level of ordinary skill in the pertinent art and evaluating evidence of secondary consideration. According to the MPEP, the Applicant's invention must be considered as a whole, the references must also be considered as a whole and suggest the desirability of making the combination of references. Further, the references must be viewed without impermissible hindsight and there is a reasonable expectation of success. The Applicant has described in detail the scope and contents of the prior art, set forth the difference between the prior art and the claimed invention, and described the ordinary skill in the art. In order to make a prima facie case of obviousness, the teachings or suggestion to make the claimed

combination must be found in the prior art and not in the Applicant's disclosure. Further, the Examiner must provide an objective reason to combine the teachings of the reference. The Applicant submits that there is no teaching in the prior art cited by the Examiner to suggest a system for taking a mesh model, performing a CAE analysis and using that analysis to vary a design parameter using direct surface manipulation of the mesh model to update the model based on the updated parameter. The present invention avoids the need to update a CAD model during the design process in order to evaluate a changed design parameter. The problem solved by the Applicant is clearly a different problem than the problem solved by the cited references.

Therefore, it is respectfully submitted that claim 1 and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. §103(a).

Claim 3 was rejected under 35 U.S.C. §103(a) as being unpatentable over Beale in view of Hariya et al., in further view of Sederburg, U.S. Patent Number 4,821,214. The Applicant respectfully traverses this rejection. Claim 3 is a dependent claim. Applicant submits that claim 1 is allowable for the reasons set forth above; therefore the dependent claim is likewise allowable.

Claims 9-11 and 13-15 were rejected under §35 U.S.C. 103(a) as being unpatentable over Beale in view of Blacker (U.S. Patent Number 5,315,537). Applicant respectfully traverses this rejection for the reasons set forth previously with respect to Beale.

Beale is clearly distinguishable from Applicant's invention since Beale merely discloses a method of converting a CAD model into a grid or mesh, and not a method of taking a mesh model, performing a CAE analysis and using that analysis to vary a design parameter using direct surface manipulation of the mesh model to update the model based on the updated

parameter. Therefore, claims 9-11 and 13-15 are allowable over the rejection under 35 U.S.C. §103(a).

Based on the above, Applicant submits that the claims are in a condition for allowance, which allowance is respectfully solicited. If the Examiner finds to the contrary, it is respectfully requested that the undersigned in charge of this application be called at the telephone number given below to resolve any remaining issues.

Respectfully submitted,

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